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Over Batch Analysis for the LLNL Plutonium Packaging System (PuPS)

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Over Batch Analysis for the
LLNL Plutonium Packaging System (PuPS)

Revision 1

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1.0 Summary

This document addresses the concern raised in the Savannah River Site (SRS) Acceptance Criteria (Reference 1, Section 6.a.3) about receiving an item that is over batched by 1.0 kg of fissile materials. This document shows that the occurrence of this is incredible.

Some of the Department of Energy Standard 3013 (DOE-STD-3013) requirements are described in Section 2.1. The SRS requirement is discussed in Section 2.2. Section 2.3 describes the way fissile materials are handled in the Lawrence Livermore National Laboratory (LLNL) Plutonium Facility (B332). Based on the material handling discussed in Section 2.3, there are only three errors that could result in a shipping container being over batched. These are: incorrect measurement of the item, selecting the wrong item to package, and packaging two items into a single shipping container. The analysis in Section 3 shows that the first two events are incredible because of the controls that exist at LLNL. The third event is physically impossible. Therefore, it is incredible for an item to be shipped to SRS that is more than 1.0 kg of fissile materials over batched.

2.0 Background

2.1 3013 Requirements

The DOE-STD-3013 (Reference 2) limits the mass of materials in the containers. The limits are 4.4 kg of Pu or U and 5.0 kg of bulk weight. Therefore, a 1.0 kg over batch of fissile material would result in 5.4 kg of fissile material and 6.1 kg bulk weight for pure plutonium oxide.

2.2 SRS Requirement

Section 6.a.3 of the SRS Acceptance Criteria (Reference 1) states the following:

> Sufficient controls are established at the loading facility to ensure that the maximum credible (i.e. frequency >1E-6) over batch (process upset condition) for the loaded 9975 shipping container is 1.0 kg of fissile materials. This determination shall be documented in a shipper site safety evaluation, a copy of which shall be provided to SRS for review and concurrence.

This requirement is based on the authorized basis of using the K Reactor building as a storage area for unopened 9975 shipping containers with welded shut 3013 cans in them.

2.2 LLNL Material Handling

The 3013 cans are loaded and welded in the Plutonium Packaging System (PuPS) that is located in the Plutonium Facility at LLNL. The movements of fissile materials are closely controlled in the facility because of criticality, Material Control and Accountability (MC&A), and security concerns.

2.2.1 Controls:

Many of the controls associated with LLNL material handling are in place for criticality and MC&A control. One of the important control parameters for criticality control is the mass of fissile materials. Therefore, these controls also control the mass of fissile materials in a 3013 can. The controls that are used include:

MC&A Plan
The MC&A Plan (Reference 3) is consistent with the requirements of DOE Manual 470.4-6 (Reference 9), and has been prepared in accordance with implementing MC&A Plan Format and Content Guide. DOE Order Manual 470.4-6 requires that the reportable level for plutonium and fissile uranium is grams. The accidental or purposeful diversion of 1.0 kg of Pu or U^{235} would be quickly detected within the implementation of the MC&A Plan

Move Procedure
The Move Procedure (Reference 6) requires two Fissile Material Handlers (FMHs) to verify what is in the shipping workstation, the receiving station, and the specific item to be moved before transferring materials between workstations. When the move is completed, two FMHs verify that the proper item had been moved before the transfer is complete. Appendix A contains the operator aide for the Move Procedure.

COMATS
The FMHs use the <u>CO</u>ntrolled <u>M</u>aterials <u>A</u>ccountability and <u>T</u>racking <u>S</u>ystem (COMATS) to assist with maintaining MC&A. The use of COMATS requires two knowledgeable people to verify what material is being moved and two knowledge people to acknowledge the receipt of material. The COMATS also keeps track of the fissile content of each item. Therefore, the quantity of fissile materials in each package is constantly available. The COMATS also checks moves against the criticality limits for the workstations before allowing a move. Appendix B contains a description of the COMATS.

Criticality limits
The criticality limits restrict the amount of fissile materials that can be used in a workstation (Reference 4, Section 5.1.2). The criticality limits for the workstations associated with the Plutonium Packaging System (PuPS) are limited to 4.5 kg of Pu and ^{235}U (Reference 5). This is slightly over the DOE-STD-3013 container limit of 4.4 kg Pu

and U^{235}. The workstations (WSs) associated with the PuPS are located in Room 1010 and are:

WS1019: floor of the PuPS Glovebox (LLNL Glovebox 5),
WS1020: storage well in the PuPS Glovebox,
WS1021: Inner Can Welding Hood, and
WS1022: Outer Can Welding Hood.

Any item containing 5.4 kg of Pu and ^{235}U would violate the criticality limits on these workstations. The workstations are prevented from exceeding criticality limits by having the FMH check the receiving workstation criticality conditions before a move is performed (move procedure) and the COMATS also checks that the criticality limits are not exceeded. If the COMATS determines that the criticality limits are exceeded, it warns the operator. Therefore, a container with a known quantity of greater than 4.5 kg of Pu would not be moved into the PuPS Glovebox.

Requiring material measurements when moving material between MBAs
When a fissile material-containing package moves between the Material Balance Areas (MBAs) where the fissile material is packaged in the PuPS (located in MBA 850) and the vault storage or shipping preparation areas (MBA 100) the package content is measured. Therefore, before an item can be moved into MBA 100 from MBA 850, the fissile content requires measurement.

Shipping container load procedures.
This ensures that shipping containers are loaded properly.

Calibration check of scales each day they are used.
Each day that a scale is used, the calibration of the scales is checked using 4 different calibrated weights by the FMHs. The scales must measure within their control limits to be used.

2.2.2 Material Handling Example for Oxide

A single example will be used here to show the reader how material is handled in the Plutonium Facility at LLNL. However, there are a number of other options available for processing such as material moved from the metal or oxide preparation box rather than the vault. For this example we will assume that there are three cans each containing 2 kg of plutonium as an oxide, located in the vault. This material will be transferred to a workstation in MBA 850 where the oxides will be packaged into convenience cans before transfer into the PuPS Glovebox. The convenience can will be limited to 4.4 kg of plutonium and 5.0 kg of bulk weight per the 3013 Standard (Reference 2).

Before the material will be released from the vault, the fissile content will have been determined by non-destructive analysis (NDA) such as calorimetry and gamma isotopics. During this time, the material is placed on measurement hold by the Measurement Verification and Control Group. This is done in the COMATS as an administrative control to prevent further processing of the material before measurements are complete and analyzed. The measurements are made by Material Management Operations personnel and are submitted to the Measurement Verification and Control Group. The Measurement Verification and Control Group analyses that data to determine if the information meets the quality control requirements. This review includes the comparison of readings made from standards, repeatability of measurements, and a comparison of the readings to the amount reported to be in the container. If the measurements pass all of the reviews, the Measurement Verification and Control Group removes the measurement hold.

When the fissile content is established, it is available for processing. A request is made to Materials Management Operations (MM) for the items. A COMATS transfer is initiated using the Move Procedure. The shipper (MM) and receiver (FMH in Room 1010) identify the material to be moved and the destination and intermediate workstations. Then the contents of the receiving, sending, and intermediate workstations are verified using two people. The COMATS system is then consulted to verify that it is safe to transfer the material through the workstations. Once this has been checked, the shipper initiates the transfer in COMATS. The cans are removed from the vault storage area and transported to Room 1010 by two FMHs. Then the cans are transferred into WS1016. The move is completed by having two FMH verify that the appropriate item had been moved.

In WS1016, the three cans of oxide are opened and they are combined into a convenience can to obtain a maximum mass of 4.4 kg Pu and a maximum of 5.0 kg net weight. The remaining 1.6 kg Pu is placed into a separate container. Each of these items will be given a new unique serial number (SN#) and be re-characterized by recording information about the item such as net weight, packaging configuration and fissile weight into COMATS. This information is entered by one FMH and verified by another FMH. Then the 4.4 kg Pu container is closed in WS 1016.

The canned oxide is transferred to WS1019 (floor of the PuPS glovebox) through the tunnel by using the Move Procedure and

COMATS. Again this requires two FMHs to verify that the proper can has been moved.

In WS1019, the can is re-weighed to verify that there has not been a significant weight gain. The weighing also checks that the plutonium contents are within the 3013 requirements of a bulk weight of 5.0 kg and fissile material weight of 4.4 kg. The criticality limit for this WS is 4.5 kg Pu and ^{235}U.

Next the convenience can is transferred to WS1021 (Inner Can Welding Hood) using COMATS and the Move Procedure. A second FMH has to verify that the appropriate can had been moved. The criticality limit for this WS is 4.5 kg Pu and ^{235}U. Then the Inner Can is welded and cut. The welded Inner Can is than checked for contamination and leak checked. The welded Inner Can is re-characterized with a new unique SN# for COMATS. The COMATS SN# will contain the Inner Can SN#.

The welded Inner Can is then transferred to the WS 1022 (Outer Can Welding Hood) using COMATS and the Move Procedure. Again, the transfer is verified by a second FMH. The criticality limit for this WS is 4.5 kg Pu and ^{235}U. Then the Outer Can is welded. The item again will be re-characterized and given a new unique SN# for COMATS. The COMATS SN# will contain the Outer Can SN#. It is transferred back to WS 1021 using the COMATS and the Move Procedure for leak checking.

The Outer Can is then transferred to MM for NDA and storage. This involves review by two FMHs from Room 1010 and two MM personnel to complete the transfer. The MM personnel check that the appropriate item has been transferred before they complete the move. When the MM receives the item, they weigh the item and then inform the Measurement Verification and Control Group, who place a measurement hold on it.

The can may go to the vault for storage while awaiting queuing into the measurement station. The MM personnel measure the container using NDA such as calorimitry and gamma isotopics. The measurements are made by Material Management Operations personnel and are submitted to the Measurement Verification and Control Group. The Measurement Verification and Control Group analyzes that data to determine if the information meets the quality control requirements. This review includes the comparison of readings made from standards, repeatability of measurements, and a comparison of the readings to the amount reported to be in the container. If the measurements pass all of the reviews the Measurement Verification and Control Group removes the measurement hold.

After the measurement hold has been removed, the 3013 Outer Can will be stored or transferred for packaging for shipping. This transfer involves COMATS, the Move Procedure and two MM personnel verifying that it had moved to the new MBA. The 3013 Outer Can will be load into the 9975 shipping containers. The 3013 Outer Can is placed into the Primary Containment Vessel (PCV) of the 9975. The lid is screwed on and leak checked. Then the PCV is lowered into the Secondary Containment Vessel (SCV) and the lid of the SCV is screwed on and leak checked. Then the SCV is lowered into the 9975 overpack and the overpack is closed.

2.2.3 Material Handling Example for Metal

The packaging of metal is similar to that of packaging of the oxide except that metal is packaged with a maximum of 2.5 kg Pu and ^{235}U into 4" x 4" cans. Two 4" x 4" cans can with a maximum fissile content of 4.4 kg be loaded into the 3013 Inner Can.

3 Analysis

Based on the above example the following errors could occur that might result in the final 9975s being over batched:

- Incorrect measurement of an item: An error is made in the measurement such that the reported value is 4.4 kg instead of 5.4 kg of fissile materials, which is the actual value.
- Selecting the wrong item for packaging, and
- Placing more than one 3013 can in a 9975 shipping container.

Each of these errors are analyzed below.

3.1 incorrect measurement of the item

3.1.1 Postulated Error

The postulated error for this situation is that the measurement was made incorrectly such that the measured value is much lower (1 kg of SNM) than the actual value. The rigorous review of the measurements and the accuracy of the measuring devices as required by DOE Manual 470.4-6 prevent this.

3.1.2 Measurement System

Reference 3 discusses the measurement controls in Section 7.3.8 and is summarized here:

All measurable SNM items entering storage locations in Building 332 are placed on measurement hold so that they can receive accountability measurements. The Measurement Verification and Control Group Personnel review daily reports of items entering the storage locations and determine which items are measurable.

The Measurement Verification and Control Group completes an Inventory Measurement/Characterization Form (MRF) for all items requiring measurement. Completed forms are forwarded to the Operations Group personnel who perform the measurements.

After a required measurement has been completed, the MRF and all measurement printouts are forwarded to the Measurement Verification and Control Group. The Measurements Verification and Control Group personnel check the measurement control charts for the relevant instruments to determine if appropriate standards were assayed before and after the accountability measurement and if the measurement system was within the control limits of the equipment. The Measurement Verification and Control Group personnel also review the measurement output to determine if the results seem valid. This review included comparing results to book values and any previous measurement results, if available. For accountability/ verification measurements, the differences between book values and measurement results are compared to the verification measurement acceptance/rejection criteria.

If significant differences exist between the latest measurement results and book values or previous measurements, additional measurements are required on a new MRF and an examination of potential reasons for disagreement is started. If further measurements support a difference and examination of all records does not indicate any potential diversion, the accountability database is updated. The booked SNM element weight can never exceed the net weight of the item.

After all measurement issues have been resolved the Measurement Verification and Control Group personnel sign the MRF and the item is taken off of measurement hold.

The independent measurements and review of the measurements and methodology ensure that an accurate reading is made from the machine.

3.1.3 Equipment Uncertainty

The mass of fissile materials is determined by using various NDA equipment including: neutron multiplicity counter, segmented gamma scanner, calorimitry, and gamma isotopics. The accuracy of these instruments are:

Instrument	Accuracy	Section of Reference 3
Neutron Multiplicity Counter	Standard Deviation of 0.0202	Page F-2
Segmented Gamma Scanner	3.1% Uncertainty	Page G-3
Calorimetry	Standard Deviation 0.28%	Page H-5
Gamma Isotopics	0.116% Uncertainty	Page I-2

The preferred NDA methods are calorimetry and gamma isotopics. The gamma isotopics are used to determine the ratio of the isotopics and the calorimeter to determine the amount of the nuclides. The 3013 can is packaged with 4.4 kg of fissile material. Assuming that it is weapons grade (WG) plutonium, it would generate about 12 W (see Table 1). Calorimeter 29 would be used to measure the heat generation of this can. It is capable of measuring 3.7 to 20 watts (Reference 3, pg. H-1). If the can had a 1.0 kg over batch, it would contain 5.4 kg of WG Pu, which would generate 15 W (Table 1). The standard deviation for the total uncertainty for this calorimeter is 0.28% (Ref 3, page H-5)

Table 1: Power Generation for 15 Year-Old Weapons Grade from Reference 7, pg. 3-86

Isotope	wt%	Watts/gram Element	Watt/gram Total
Pu238	0.036	0.567	0.00020412
Pu239	93.3	1.93E-03	0.00180069
Pu240	5.99	7.09E-03	0.00042469
Pu241	0.282	3.41E-03	9.6162E-06
Pu242	0.04	1.16E-04	4.64E-08
Am241	0.294	0.1145	0.00033663
		Watts/g WG Pu	**0.00277579**
		4.4 kg WG Pu	**12.2 W**
		5.4 kg WG Pu	**15.0 W**

3.1.4 Probability of Error

The probability of the calorimeter reading being off by 1 kg is determined by looking at how many standard deviations it is off from the normal. There is a 65% probability that the measured number is within 1 standard deviation of the actual number, 95% within 2 standard deviations, and 99.7% within 3 standard deviations. For the measurement to be off by 1.0 kg from the actual value requires an inaccuracy of (5.4-4.4)/4.4 = 22.7% or 22.7/.28% = 81 standard deviations. This means that it is incredible for the instrument to be off by 1.0 kg.

The combination of the accuracy of the measurement equipment with the rigorous review of the data by the Measurement Verification and Control Group insures that the measurement of the material will not be off by 1.0 kg of fissile materials.

3.2 Selecting the wrong item to ship.

3.2.1 Postulated error

This error would be caused by selecting an incorrect item to be shipped. This could occur by the operator packing item A when he should have packaged item B or if the item was packaged before its measurements were complete and the fissile content had been verified. If the fissile content of the item incorrectly selected was 4.4 kg or less of Pu and U^{235} this would still not over batch the shipping container. The preparation of the 3013 cans is controlled such that the probability of over batching them is about 10^{-12} (See Section 3.2.4)

3.2.2 Description of System

There are a number of controls in place to ensure that the proper material is packaged and transferred. These controls have been instituted for the purposes of criticality and MC&A control. They also ensure that the 3013 cans are not over batched. Many of these controls are administrative and therefore the probability of an error is determined by human error rates. These controls include:

Implementation of the MC&A Plan
This ensures that material will not be packaged for shipping before being measured.

The criticality limits
The criticality limits on the PuPS workstations are set at 4.5 kg of Pu and ^{235}U. This is slightly over the 3013 allowable amount of fissile materials (4.4 kg) but less than 1 kg over the 3013 limit.

Calibration check of scales each day they are used.
Each day that a scale is used for MC&A measurements, the calibration of the scales are checked using 4 different calibrated weights by the FMHs. This insures that the weighing is accurate.

Move Procedure
The Move Procedure requires the shipper and receiver to both understand what is being sent. Therefore, if the receiver gets a

different item than expected, he will stop the transfer and investigate the cause.

COMATS

The use of the COMATS system requires two individuals to verify any modifications of materials. This provides a double check of all operations including material balances.

3.2.3 System Uncertainty

The human error probabilities associated with material movements were developed as part of the B332 Documented Safety Analysis (Reference 7, Appendix B). The probabilities used were:

Event	Failure Probability
Failure of administrative control (nominal value)	5×10^{-3}
Checker (or second operator) verification error (nominal value)	1×10^{-1}

3.2.4 Probability of Error

The Human Error Probabilities and the LLNL handling description (Section 2.3) were used to develop a fault tree to determine the probability of this error occurring. The fault tree is shown in Figures 1, 2 and 3.

For an over batch item to get to SRS requires that an over batch item be created and then the over batch item needs to be packaged. First an over batch item needs to be created. The fault tree for calculating the probability of this occurring is shown in Figure 1. Material is moved into a glove box and assembled into convenience can(s). At this point two operators verify that the amount of material in the convenience container(s). This is represented by events 1, 2, 3 with the FMHs mis-reading the scale at a probability of 5.0×10^{-4}. There could also be a computer error such as data entry that could also generate an over batched convenience can (events 4, 5 and 6). These result in a failure probability of 5.0×10^{-4}. Either of these errors could result in an over batched convenience can. Therefore, the probabilities are added to give 1.0×10^{-3} (event 7). Then the convenience can is transferred to the 3013 welding glovebox where the material is weighed again. To generate an over batched 3013 can requires that when the FMH checks the weight of the convenience cans(s) the same kind of scale mis-reading failure occurs, with a failure probability of 5.0×10^{-4} (events 8, 9, 10). Then the part is sent to the vaults. Prior to putting the 3013 container into storage it is weighed again to verify the weight. The probability of failure for this is the same as for the initial 3013 weighing (events 11, 12, and 13). Therefore, the probability that an over batched 3013 container will get stored in the vault has an overall probability of failure of 2.5×10^{-10} (Event 14),

To place this over batched can into a shipping container requires that either the wrong container is selected and placed in the shipping package or the over batched container is believed to be under mass (was not measured) and it is placed into the shipping container. The probability of selecting the wrong container is shown in Figure 2. The item is retrieved from the vault by two FMHs and is transferred to the packaging area. The probability that the FMHs will select the wrong container has a probability of 5.0×10^{-4} and is covered by events 15, 16, and 17. At the packaging area the items is checked against the paperwork to ensure the correct container is being packaged. The probability of failure there is covered by events 18, 19, and 20. Both the first check and the second check have to be satisfied before the container will be packaged. Therefore, the probabilities are multiplied, resulting in a probability of receiving the wrong container as 2.5×10^{-7} (Event 21).

The probability of packaging an over batched can is shown in Figure 3. The left branch covers the case where a wrong container is selected and it is over batched. This has the probability of 6.3×10^{-17} (Events 21, 14, and 23). The right branch is for the case where the container is over batched and it was not measured. When a container is sent to MM, it is placed on a list to be measured. If it did not get on the list then it would not be measured and would not be placed on measurement hold. The probability of the item not getting placed on the measurement hold list is 5.0×10^{-3} (event 22). Combining this with the probability that the container is over batched results in a failure probability of 1.3×10^{-12} (event 24). Since the shipping package can be over batched by using a wrong can that is over batched or by an unmeasured can that is over batched, the probabilities are added. This results in the overall probability of an over batched shipping packaging of 1.3×10^{-12} per operation (Event 25).

3.3 Double loading the shipping container.

3.3.1 Postulated Error

It has been shown that it is incredible to send a 3013 can with greater than 5.0 kg of fissile materials to be shipped. It is conceivable that the shipping container could be over batched if two 3013 container were inserted into it. The physical structure of an assembled 9975 shipping container and the use of the 9975 loading procedure precludes this from occurring.

3.3.2 Description of System

The configuration of the 9975 is shown in Figures 4 and 5. These figures and the following information are from Reference 8. The Primary Containment Vessel (PCV) has an internal size of 15 inches deep and a minimum diameter of 5.02 inches. The 3013 outer can has the dimensions of 10 inches tall and 4.963 inches in diameter. Therefore, only a single 3013 can physically fit within the PCV of the 9975.

The Secondary Containment Vessel (SCV) has an internal depth of about 21.5 inches. Therefore, two 3013 Outer Cans can be placed into a SCV. The probability of this is incredible because the procedure specifies how the packaging goes together and it also requires leak checks on both the PCV and SCV before the drum can be closed.

3.3.3 Probability of Error

The probability of error is incredible because the packaging of the 9975 will be done by a procedure that requires a number of checks to verify that the equipment is assembled correctly including leak checks of the PCV and SCV.

4.0 Results

This paper showed that there are sufficient controls at LLNL to ensure that the maximum credible (i.e. frequency >1E-6) over batch (process upset condition) for the loaded 9975 shipping container is 1.0 kg of fissile materials. The controls assure that:

1) The probability of a measurement error is incredible because of the accuracy of the measurement equipment and the rigorous review given to it before the packaged material is released,
2) The probability that an unmeasured 3013 can containing greater than 5.4 kg of fissile materials was incredible, and
3) The probability of more than one 3013 can being loaded into a 9975 was incredible.

5.0 References

1) “Savannah River Site Stabilization and Packaging Requirements for Plutonium Bearing Materials for Storage,” G-ESR-G-00035, Revision 1, July 26, 2000.

2) “Stabilization, Packaging, and Storage of Plutonium-Bearing Materials,” DOE-STD-3013-2004, U.S. Department of Energy, April 2004.

3) “Material Control & Accountability Plan”, Michael K. Sheaffer and Robert Marsh, 12/1/2006

4) “Plutonium Facility—Building 332 Facility Safety Plan”, FSP-332-07, Defense and Nuclear Technologies Directorate, Lawrence Livermore National Laboratory, April 2007.

5) “Plutonium Packaging System,” OSP 332.190, Lawrence Livermore National Laboratory, 8/31/08.

6) “Operating Procedure for B332 Fissile Material Movements,” OP-B332-01, Lawrence Livermore National Laboratory, February 29, 2000.

7) ”Defense & Nuclear Technologies Directorate, Plutonium Facility—Building 332 Documented Safety Analysis,” UCRL-AR-119434-05, Lawrence Livermore National Laboratory, December 2005.

8) “Model 9975 B(M)F-85, Safety Analysis Report for Packaging”, WSRC-SA-2002-00008, Revision 0, Westinghouse Savannah River Company, December 2003.

9) DOE M 470.4-6, “Nuclear Material Control and Accountability”, Change 1, 8/14/96.

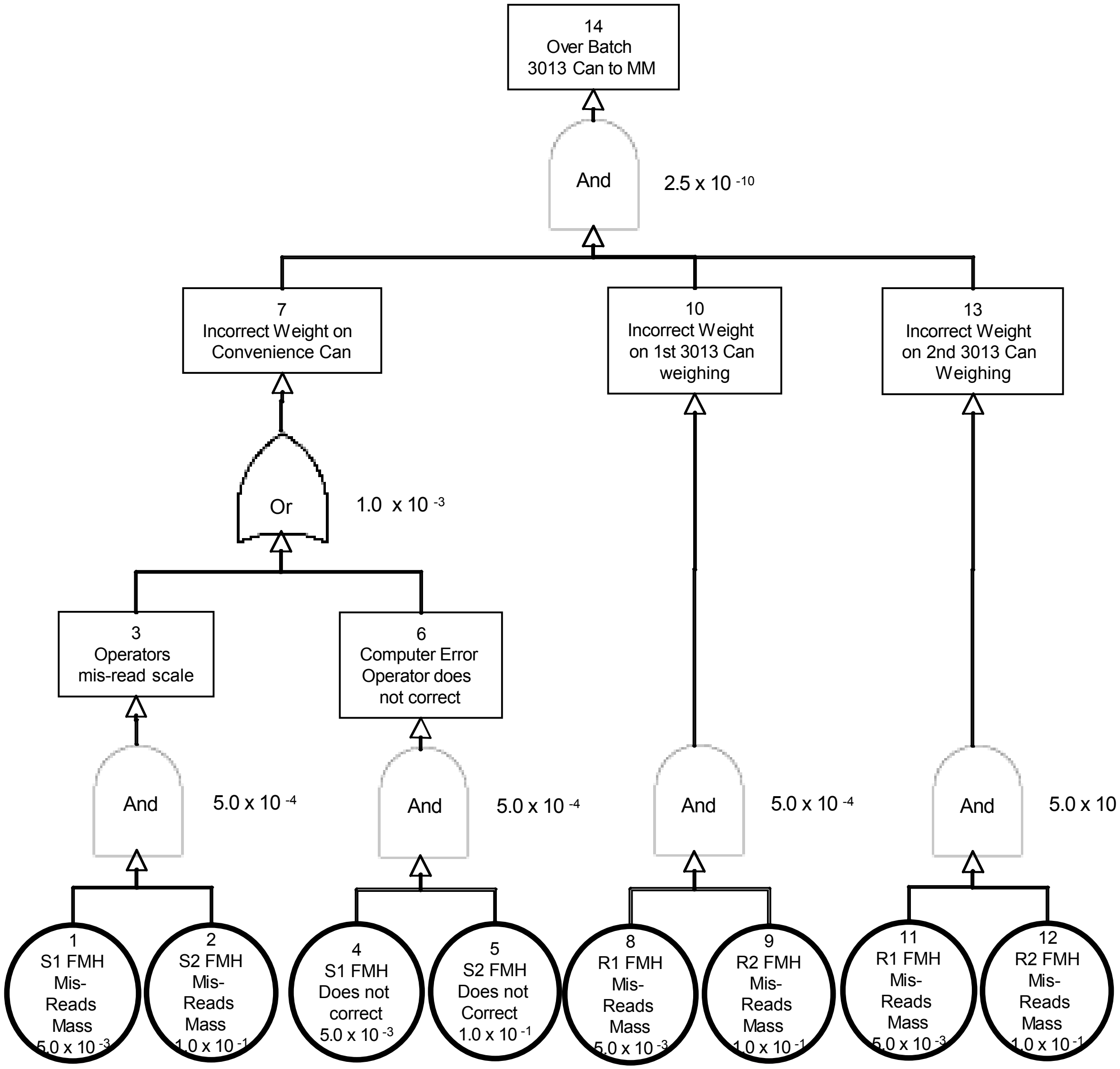

Figure 1: Fault Tree for Sending Over Batched DOE-STD-3013 Container to Materials Management

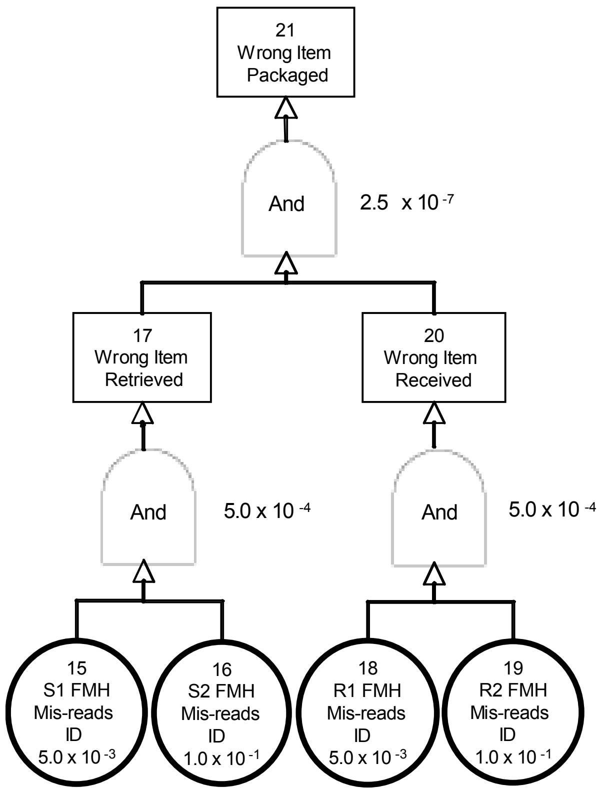

Figure 2: Fault Tree for Packaging the Wrong Container

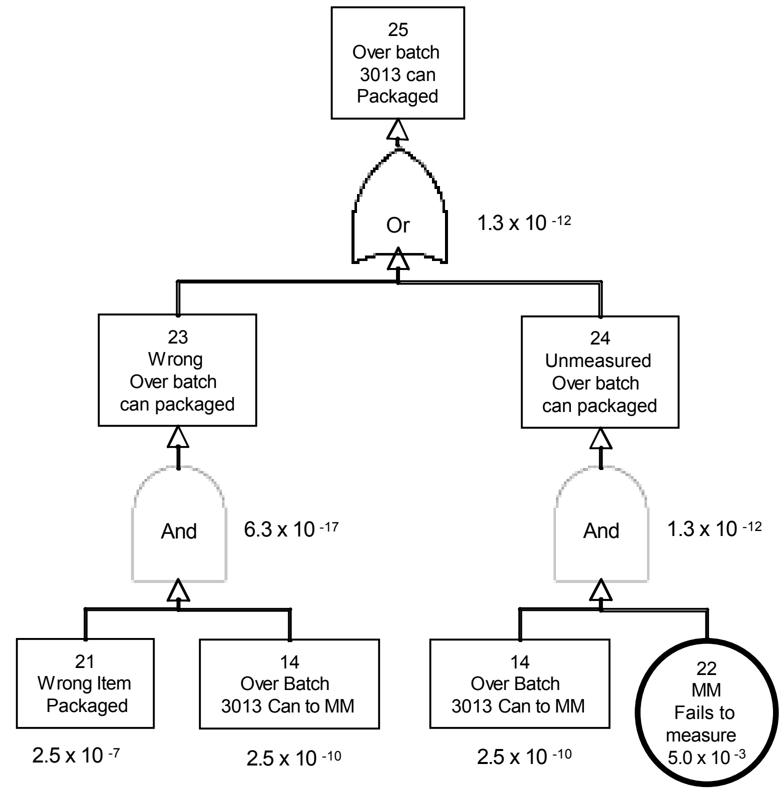

Figure 3: Fault Tree for Packaging an Over Batch Container

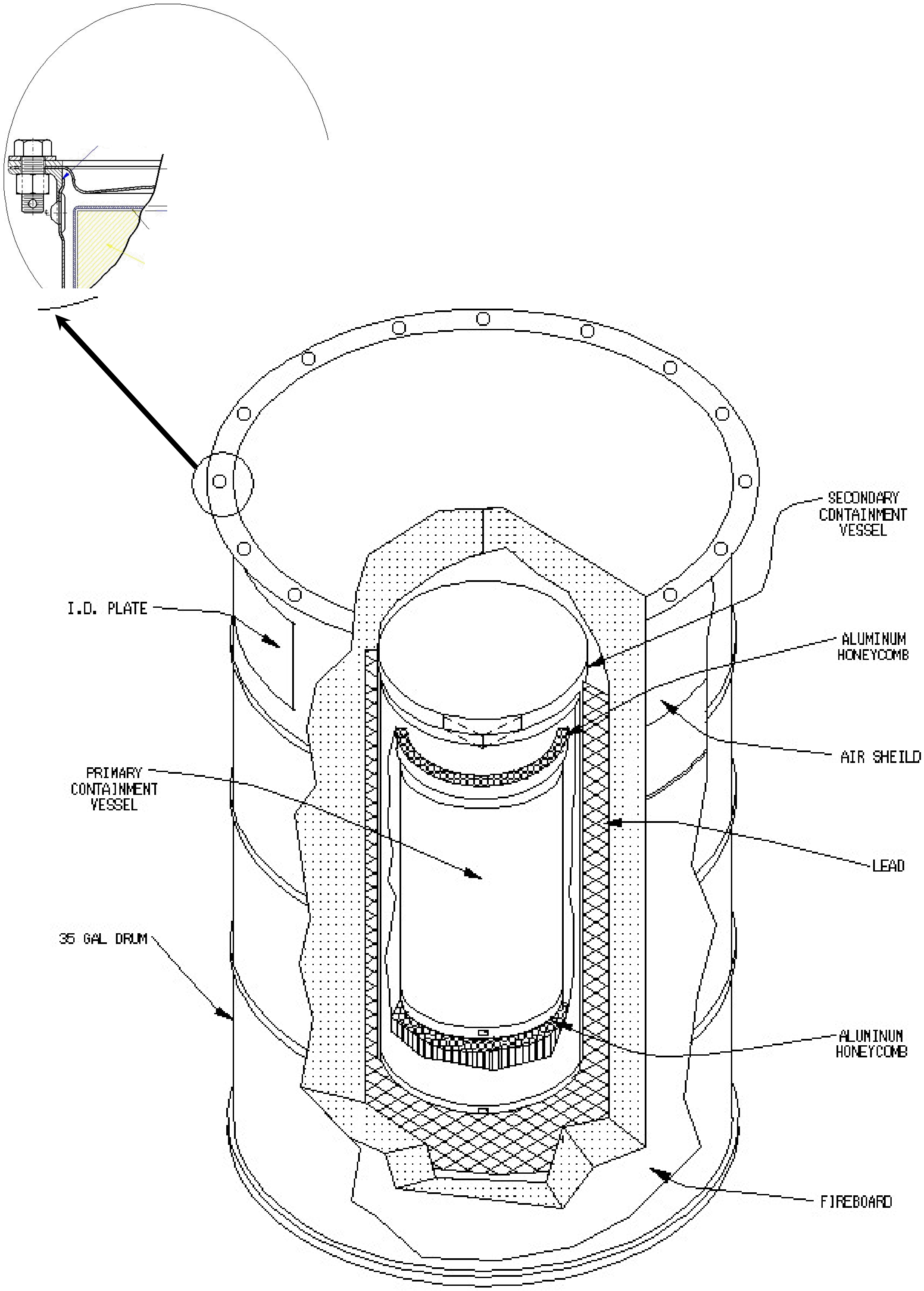

Figure 4. 9975 Package

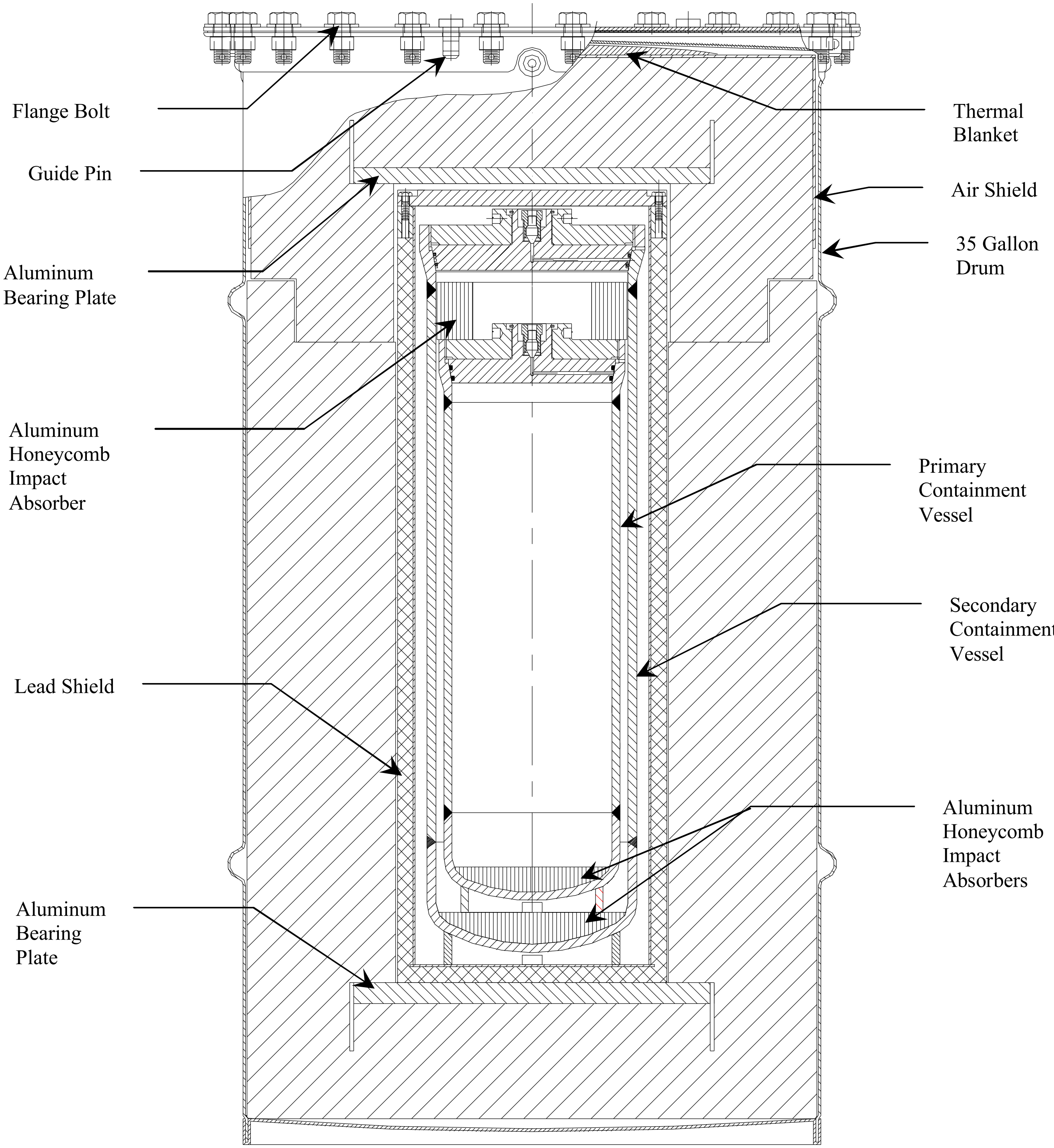

Figure 5. 9975 Assembly

Appendix A – Operators Aid for Move Procedure

Fissile Material Move Procedure
S = Shipper's responsibility;
R = Receiver's responsibility

Identify
1. **The material to be moved. (S/R)**
2. **The destination and intermediate workstations. (S/R)**
3. **OSP and FSP Controls. (S/R)**
4. **The material characteristics. (S/R)**
5. **Communicate safety information. (S/R)**

Verify
6. **Inventory the workstation(s). (S/R)**
7. **Verify the ability to safely move the material. (S/R)**
8. **Communicate the readiness to ship and receive. (S/R)**
9. **Initiate the move in COMATS. (S)**

Move
10. **Bag out the material. (S)**
11. **Move the material. (S/R)**
12. **Bag in the material. (R)**
13. **Complete the move in COMATS. (R)**

Post
14. **Post the new COMATS workstation inventories. (S/R)**

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Appendix B – COMATS description

LLNL utilizes a computer-based accounting system, the COntrolled Materials Accountability and Tracking System (COMATS), along with supporting documentation to meet DOE nuclear material accounting requirements. COMATS has two independent components, a ledger database for each material type, and an inventory database that identifies each item of inventory by material type and location. These components provide assurance that the accounting records are complete and accurate.

Every action that happens with a container of fissile materials is to be recorded in the COMATS. The operations that are recorded, include:

Moves between workstations
Combinations – putting two or more items together
Splits – separating a single item into multiple items

Each operation that is entered in the COMATS requires a verifier to check that the operation had been completed and that the data input is correct.